

1 CLAIMS

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3 1. A variable damper comprising;
4 an outer member including a magnetically conductive
5 sleeve;
6 an inner member comprising a shaft;
7 an electromagnet supported between the members;
8 wherein
9 a chamber between the outer and inner members is at
10 least partially filled with magnetorheological fluid
11 (MRF), such that when a magnetic field is applied to
12 the chamber, the effective viscosity of the fluid
13 increases such that relative motion of the inner and
14 outer members is opposed;
15 the region between the electromagnet and the sleeve
16 defining a control region in which the magnetic
17 field is concentrated.

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19 2. A variable damper as claimed in Claim 1 wherein, the
20 electromagnet is supported on the outer member.

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22 3. A variable damper as claimed in Claim 2 wherein, the
23 electromagnet is supported by a plurality of struts
24 arranged perpendicular to the shaft.

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26 4. A variable damper as claimed in Claim 1 wherein, the
27 electromagnet is supported on the inner member.

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29 5. A variable damper as claimed in Claim 4 wherein, the
30 inner member comprises interconnected first and
31 second shaft portions between which is arranged a
32 housing comprising the electromagnet.

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1 6. A variable damper as claimed in any preceding Claim
2 wherein, a diaphragm seal portion is provided at each
3 end of the shaft to bound the chamber.

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5 7. A variable damper as claimed in Claim 6 wherein, the
6 seal portion has an elasticity to allow the inner
7 member to rotate in planes perpendicular to the seal
8 portion.

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10 8. A variable damper as claimed in Claim 6 wherein, the
11 seal portion has an elasticity to reduce at least one
12 degree of freedom of the relative motion of the inner
13 and outer members.

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15 9. A variable damper as claimed in any preceding Claim
16 wherein the outer member includes a secondary housing
17 at least at one body end surface, the/each secondary
18 housing comprising a hollow cylindrical body
19 including an aperture through which the shaft
20 extends.

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22 10. A method of variably damping relative motion between
23 an outer member including a magnetically conductive
24 sleeve and an inner member, comprising the steps:

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- 26 (a) supporting an electromagnet between the members
27 such that a flow path exists between the
28 electromagnet and the sleeve;
- 29 (b) placing a magnetorheological fluid between the
30 members;
- 31 (c) applying a minimal magnetic field to the
32 electromagnet;
- 33 (d) increasing the field in the flow path; and

1 (e) increasing viscosity of the fluid to thereby
2 oppose relative motion of the membranes and
3 create damping with minimal off-state.
4
5 11. A vibration control system for reducing vibrations
6 between a first and a second element, a
7 magnetorheological fluid variable damper being
8 located between the elements and operated to cause
9 active damping between the elements, wherein the
10 system has a relative figure of merit of less than
11 0.83.
12
13 12. A vibration control system as claimed in Claim 11
14 wherein the relative figure of merit is less than or
15 equal to 0.5.
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17 13. A vibration control system as claimed in Claim 11 or
18 Claim 12 wherein the magnetorheological fluid
19 variable damper is according to anyone of Claims 1 to
20 9.
21
22 14. A vibration control system as claimed in any one of
23 Claims 11 to 13 wherein the shaft is connected to the
24 first element and the housing is connected to the
25 second element; and the system further comprises a
26 spring located between elements; first and second
27 accelerometers located between the damper and the
28 respective first and second elements; and a control
29 unit for inputting accelerometer values and
30 outputting a small electric current to the
31 electromagnet, to cause active damping between the
32 first and second elements.
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1 15. A vibration control system as claimed in Claim 13 or
2 wherein the inner and outer members of the
3 damper are configured to be suitable for attachment
4 to components of a device, such that the application
5 of relative forces between the components results in
6 corresponding forces being applied to the inner and
7 outer members of the damper.

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9 16. A vibration control system as claimed in Claim 15
10 wherein, a parasitic power generator is incorporated
11 within or on the device to provide the electric
12 current that drives the electromagnet.

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14 17. A vibration control system as claimed in Claim 15 or
15 wherein, the device comprises at least one
16 sensor that detects a variable, the value of which
17 can be used to determine a desire amount of electric
18 current to be applied to the electromagnetic coil.

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20 18. A vibration control system as claimed in Claim 17
21 wherein an intelligent control unit (ICU) is
22 provided, which is capable of receiving input signals
23 from the sensors and outputting command signals to
24 the damper, the command signals being derived from an
25 algorithm used to determine a desired relationship
26 between the input signals and the damping required.

27

28 19. A vibration control system as claimed in any one of
29 Claims 15 to 18 wherein the device is a snowboard,
30 one of the outer member and inner member of the
31 damper is attached to the surface board, and the
32 other of the inner member an outer member is attached
33 to a raised portion formed on the board.

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2 20. A vibration control system as claimed in Claim 19
3 wherein a plurality of dampers are attached to the
4 board.

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6 21. A vibration control system as claimed in Claim 19 or
7 Claim 20 wherein, torsion forks are provided on the
8 board and connected to the inner member of the device
9 to enable control of torsional stiffness of the
10 board.

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12 22. A vibration control system as claimed in any one of
13 Claims 15 to 18 wherein the device of a golf club,
14 one of the outer member and inner member of the
15 damper is attached to the shaft of the club, and the
16 other of the inner member and outer member is
17 attached to or forms the grip of the club.

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19 23. A vibration control system as claimed in any one of
20 Claims 15 to 18 wherein the device is a handle which
21 is a component of a machine, wherein the machine is
22 selected from a group comprising: a tennis racket,
23 polo mallet, sports implement, a household tool, a
24 power drill, a bicycle, a motorcycle, or the like.

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26 24. A vibration control system as claimed in any one of
27 Claims 15 to 18 wherein, the device is an engine
28 mount, pump mount, or the like.

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